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ABSTRACT

A discussion of the nasal harmony of Aguaruna, a language of the Jivaroan family in South America, approaches the subject from the viewpoint of generative phonology. This theory of phonology proposes an underlying nasal consonant, later deleted, that accounts for vowel nasalization. Complex rules that suppose a complex system of vowel and consonant deletion are stated. Issues such as geminate structures and cyclicity of syllable structure assignment are specifically addressed, and the applicability of a number of theoretical conditions is examined. Specifically, the Linking Constraint proposed by Hayes (1986) and the Uniform Applicability Condition proposed by Steriade and Schein (1986) for geminate structures are examined as well as Harris (1983) argument with regard to the relationship between the strict Cycle Condition and the cyclicity of syllabification. Results indicate that the process of nasal harmony in Aguaruna has been well accounted for by mean of the Autosegmental Theory. (MSE)

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Nasal Harmony in Aguaruna

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12 August 1987

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Table of Contents

1. Introduction 1
2. Phoneme Inventory and Representation 2
3. Nasal Harmony 4
   - 3.1. Syllable Structure 5
   - 3.2. The Position of [+N] in Underlying Representation 5
   - 3.3. Phonological Rules 9
   - 3.4. Constraints on Geminates 11
   - 3.5. Cyclicity in the Grammar 17
   - 3.6. The behavior of /h/ 20
4. Derivations 23
5. Summary and Conclusion 26

1. Introduction

The nasal harmony of Aguaruna, a language of the Jivaroan family[1] appears to spread over a series of connected vowels and glides, as with many other native languages of South America. Approaching this phenomenon from the viewpoint of generative phonology, an underlying nasal consonant is posited to account for the vowel nasalization and later is deleted(Payne(1974)). As a result of this analysis, fairly complicated rules are stated and a complex system of vowel and consonant deletion is involved.

In the present paper, we will adopt a theory of phonology that has the familiar autosegmental characteristics with matters of detail to be discussed as they become relevant to the analysis. Phonological features can be treated prosodically; that is, they can be represented on separated autosegmental tiers, associated in a systematic way with units on the segmental level. Thus the nasal feature among phonological features is represented on a separate autosegmental tier. We will refer to the nasal autosegment as [+N] and to the segments with which [+N] is associated as N-bearing units.

In the subsequent sections we give first the phoneme inventory and specify underlying representations for the phonemes of Aguaruna on the basis of the nonlinear framework presented by Goldsmith(1976) and Clements(1980,1985). A skeleton consisting of unspecified skeletal x slots, as proposed by Levin(1985), is adopted for both underlying specification and the notation of syllable structure. Secondly, we shall account for the process of nasal harmony in terms of the well-formedness condition following the work of

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[1]Pike and Larson(1964) suggest that Aguaruna is a member of the Jivaro language family. The Aguarunas populate the northern jungles of Peru and are scattered chiefly along the Upper Maranon River and its many tributaries, from the Pongo de Manseriche on the east to the Chinchipe on the southwest. No accurate census has been taken. The informant estimated that there were some 8,000 persons who spoke Aguaruna. A very small minority of these are bilingual, speaking some Spanish.

Pulleyblank(1983), Halle and Vergnaud(1982), Goldsmith(1976), and others on tone and vowel harmony.

We shall, in particular, attempt to discuss issues such as geminate structures and cyclicity of syllable structure assignment in dealing with the data of Aguaruna, examining the Linking Constraint(LC) proposed by Hayes(1986) and the Uniform Applicability Condition (UAC) by Steriade and Schein(1986) for geminate structures, and Harris'(1983) argument with regard to the relationship between the Strict Cycle Condition and the cyclicity of syllabification respectively.

We shall argue that the LC is preferable to the UAC, although the UAC could be extended within an alternative solution. We shall discuss evidence for the cyclicity of syllabification by showing that syllabification does not obey the Strict Cycle Condition. Finally, an ordered list of rules is given and the results are summarized.

2. Phoneme Inventory and Representation

Data is taken from Payne(1974) and the phoneme inventory is given as follows:[2]

(1) voiceless stops	:	p	t		k	ʔ
voiced stops	:	b	d			
affricates	:		c	č		
nasalized assibilants	:		n_c	$n_č$		
fricatives	:		s	š		
nasals	:	m	n			ŋ
glides	:	w	y			h
flap	:		ř			
vowels	:	i	ɨ	u	a	

The Aguaruna phonemes fall into three groups; one group consists of the nasal stops (/m/, /n/, /ŋ/) which will function as triggers of nasal harmony. They will be specified as /B/, /D/, /G/ associated with a [+nasal]

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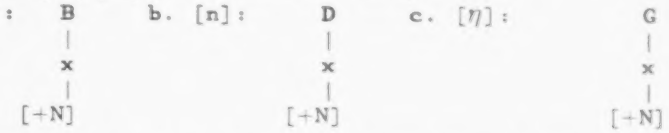
[2]The set of phonemes, which is presented by Pike and Larson(1964), is quoted from Payne's thesis.

autosegment(henceforth, [+N]) in underlying representation, where /B/ represents all the place and manner feature specifications of /m/ except for nasality, and /D/,/n/(cf. Goldsmith 1976).

(2) a. [m]: B b. [n]: D c. [ŋ]: G



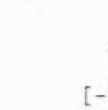
If the segments in (2.a) and (2.b) lose their [+N] autosegments, they will surface as [b] and [d]. However, we note that this language does not have the voiced velar stop /g/ corresponding to /G/.[3] From this fact we assume that if an empty position in the melody tier is associated with [+N] on the nasal tier, the segment surfaces as /G/ with default values [-ant, -cor]:

(3) [ ] → [-cor, -ant]

As we proceed further, we will see that /G/ behaves differently from /B/ and /D/.

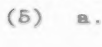
The second group of phonemes consists of the rest of the obstruents. They are underlyingly represented as opaque elements linked with [-N] at the autosegmental level. They block the spread of nasality and do not initiate a harmony of their own;

(4) [+cons] (/p,t,k,b,d,c,č, n_c,$n_{\check{c}}$, s, š/)



The third group of phonemes, glides and vowels, are assigned nasality depending on their context. Nasality is non-distinctive for these sounds. We assume that in underlying representations all vowels and glides are unspecified for [±N]. That is, they are not linked with autosegments. However, if they remain unspecified throughout the derivation, they may be redundantly specified as [-N];

(5) a. [-cons] b. [ ] → [-N]



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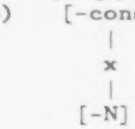
[3] /k/ has a voiced allophone [g] after /m/ and /n/, but the phones [k] and [g] never contrast in the same fashion that [b] and [d] do with the voiceless stops [p] and [t] respectively.

The phoneme /h/ behaves differently from /w/ and /y/. /h/ is underlyingly associated with [-N], even though it can be nasalized.

(8)


We return to the properties of /h/ shortly.

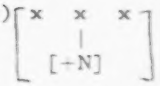
3. Nasal Harmony

Aguaruna has a characteristic process of vowel nasalization such that vowels are nasalized without nasal consonants appearing in the surface forms. The nasalization spreads automatically from the source to contiguous vowels and across the glides /w,y,h/, which are also phonetically nasalized. For the association of a free nasal autosegment to free nasal bearing units(i.e. between the nasal tier and the skeleton), we propose that the nasal process is subject to the Well-formedness Condition(WFC) in (7).[4]

(7) Well-formedness Condition
- (a) Only floating nasal autosegments are linked automatically to all N-bearing units.
- (b) Each slot is linked to at most one nasal autosegment.
- (c) Association lines do not across.

Hence a configuration such as (8) will trigger the association convention while (9) will not(cf. Pulleyblank 1983).

(8)

(9)


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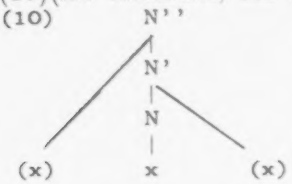
[4]This WFC is a composite of the association convention (7a.b) proposed by Halle and Vergnaud(1982), and the Well-formedness Condition(7c) originally proposed by Goldsmith(1976).

3.1. Syllable Structure

First, in order to establish correct underlying and surface representations, it should be pointed out that this language has (C)V(C) syllable structure as in (10)(for notation, see Levin 1985).

(10)



There is no rule of complex N formation, so that each vowel defines a new syllable nucleus.

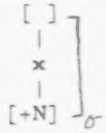
3.2. The Position of [+N] in Underlying Representation

Let us begin by considering the following minimal pairs:[5]

(11)	a.	sù.w̃ĩ	'throat'	vs.	su.wi	'dark'
	b.	ỹà.ỹà	'rat'	vs.	ya.ya	'star'
	c.	kà.ĩ	'sister'	vs.	ka.i	'avocado'

These examples show the contrast between oral on the one hand and nasal glides and vowels on the other hand, although vowels and glides never contrast minimally with respect to nasality. To account for the above contrasts, we will argue that there is an unspecified nasal segment in syllable final position. This unspecified segment will be delinked under certain circumstances detailed below, and will create a floating [+N] which will behave as a source of nasal spreading. Such a segment will look as follows;

(12)



This proposal is based on the fact that there are numerous surface forms found in Aguaruna which contain a syllable final nasal consonant or a nasal

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[5]Lowered dots stand for syllable divisions.

consonant preceding another consonant as in (13),[6] which do not undergo nasal spreading.

(13) a. a.in.c 'people' b. ba.čiŋ.ki.n 'monkey'(object form)
c. ha.an.č 'cloth' d. čaŋ.ki.n. 'basket'

Let us consider the underlying representation of (11). Under the assumption mentioned above, namely that there is an unspecified nasal segment in syllable final position, the underlying forms might be illustrated in three ways depending on where we posit an unspecified nasal segment. If we represent an unspecified nasal segment in the first syllable final position, then the underlying representations will be:

(14) a. su[ ].wi vs. d. su.wi
xx x xx xx xx
[-N] [+N] [-N]
b. ya [ ].ya vs. e. ya.ya
xx x xx xx xx
[+N]
c. ka [ ].i vs. f. ka.i
xx x x xx x
[-N] [+N] [-N]

A conceivable alternative is to represent an unspecified nasal segment in word-final position as follows:((14d-f) remain unchanged).

(15) a. su.wi[ ] b. ya.ya[ ] c. ka.i[ ]
xx xx x xx xx x xx x x
[-N] [+N] [+N] [-N] [+N]

Finally, an unspecified nasal segment could be specified in every syllable final position.

(16) a. su [ ].wi[ ] b. ya[ ].ya[ ] c. ka[ ].i[ ]
xx x xx x xx x xx x xx x x
[-N] [+N] [+N] [+N] [+N] [-N] [+N] [+N]

On the other hand, one could argue for a simpler analysis by introducing a

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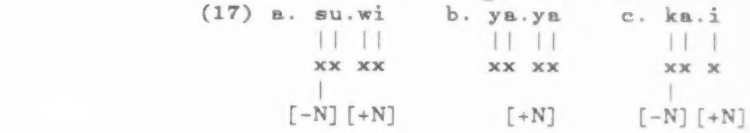
[6]These examples have undergone vowel deletion in word final position. This language has a productive vowel deletion rule which is relevant to nasalization. In particular, the rule of x-deletion (to be presented later) must precede the Vowel Deletion Rule (VDR). However, as it is not in the scope of this paper to discuss the specific formulation of vowel deletion, we will just mention the fact that the vowel deletion rule has applied, where relevant.

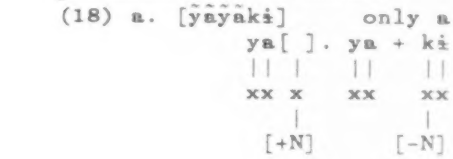
base-generated floating [+N] in the lexicon, since this analysis does not have to establish an empty position on the melody tier and association lines for an unspecified nasal segment in underlying representation. Moreover, in the process of derivation this analysis does not need a phonological rule which causes a nasal autosegment to float.

(17) a. su.wi b. ya.ya c. ka.i

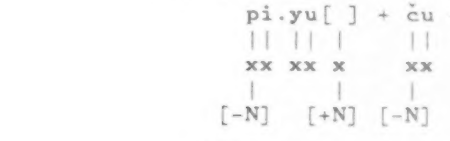


Choice of the correct underlying form can be resolved by examining a distinction made by certain speakers, most of whom are older members of the community. For these speakers, when a suffix which begins with an obstruent is added to the stem in question, the sequence is not nasalized. The underlyingly unspecified nasal appears as an assimilated nasal segment homorganic with the following obstruent. If the underlying nasal precedes a [-cons] segment, then the entire sequence is nasalized. Therefore, the position of an unspecified nasal segment can be determined from the speakers' pronunciation as follows:

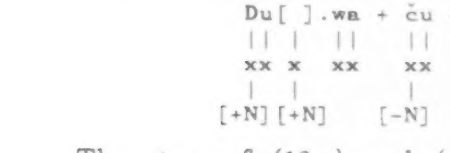
(18) a. [ỹãỹãkɨ̃] only a rat



b. [piyunčui] it isn't an insect



c. [nũw̃ãčui] it isn't a woman



The stem of (18.a) and (18.c) which contain glide and vowel sequences have undergone nasalization. This implies that the speakers of Aguaruna psychologically realize an unspecified nasal segment in the first syllable final position. On the other hand, (18.b) shows us an assimilated nasal segment homorganic with the obstruent of the following suffix /ču/ unlike (18.a).

Thus, this reveals that an unspecified nasal segment is placed in the second syllable final position.

However, not all speakers of Aguaruna make the above distinctions. Some of the younger adult members of the community pronounce the above words with dialect B in which a word may undergo either nasalization or contain homoganic nasal consonant clusters as shown in (19). It seems to be difficult for the younger members to distinguish a word which has undergone nasalization from a word which has undergone assimilation with the following obstruent when a suffix is attached to a stem.

(19)	Dialect A	Dialect B	
a.	[ỹãỹãkɨ]	[ỹãỹãkɨ]	~ [yayaŋkɨ]
b.	[piyunčui]	[pĩỹũ̃čui]	~ [piyunčui]
c.	[nũ̃wãčui]	[nũ̃wãčui]	~ [nuwančui]

It should be pointed out that younger members do not produce the following forms, where each word has undergone both nasalization and assimilation.

(20) a.* [ỹãỹãŋkɨ] b.* [pĩỹũ̃nčui] c.* [nũ̃wãnčui]

This means that they do not realize a nasal segment in every syllable final position as in (16). We conclude that (16) is wrong for the underlying forms of (11).

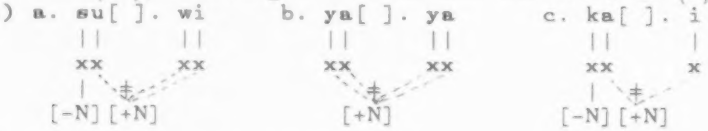
(17) might at first sight seem somewhat simpler than the other underlying forms. However, we can easily see that (17) makes the lexicon complicated once we consider words which contain a nasal segment homorganic with the following obstruent. In the case of (18.b), we need (15) as underlying representation to derive the correct surface forms in addition to (17) because we cannot account for the derivation of nasal assimilation by means of (17). Accordingly, the correct representation must be (14) or (15).

The examples of (19) provide strong support for our view that an unspecified nasal segment may occur in the first or second syllable final position in words which contain vowel and glide sequences as in (14) and (15), with quite different consequences when a stem is followed by a suffix whose first segment is an obstruent.

3.3. Phonological Rules

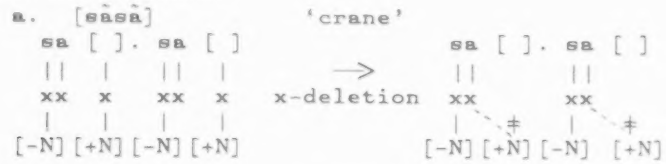
In order to account for the derivations in (11) I will take (14) as the underlying forms here. The second set of examples of (14.d-f), consisting of non-nasal consonants, glides, and vowels, are subject to no modification. They surface in their underlying forms as far as nasal harmony is concerned, since all vowels and glides are redundantly specified as [-N]. In the first set of examples (14.a-c), a rule of x-deletion(to be formulated below) will create a floating [+N] autosegment, which is linked to all accessible vowels and glides as required by (7). Derivations of the first set of examples in (11) are shown in (21), following x-deletion and the WFC in (7).

(21) a. su[ ]. wi b. ya[ ]. ya c. ka[ ]. i

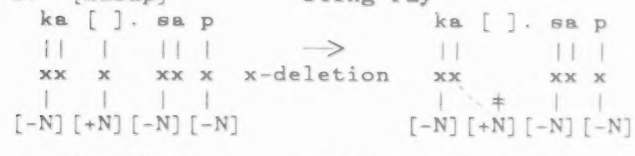


As we see above, x-deletion plays a crucial role in creating a floating [+N] autosegment. Let us consider more examples undergoing x-deletion in various environments.[7]

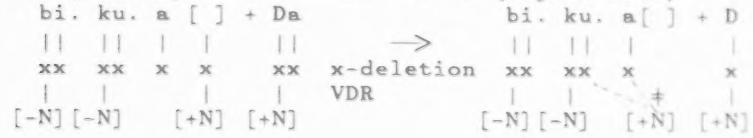
(22) a. [sãsã] 'crane'



b. [kãšap] 'sting ray'



c. [bikũan] 'small animal'(object form)



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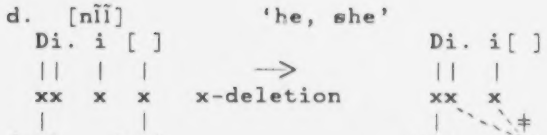
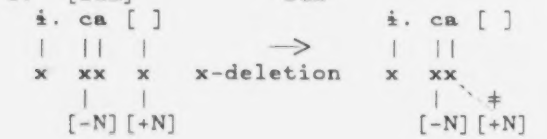
[7]We assume that the empty position of the melody tier left behind will not be realized phonetically if the skeletal slot is deleted. Alternatively, one could assume that it undergoes Stray Erasure post-lexically.

d. [nĩĩ] 'he, she'

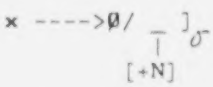


e. [ɨcã] 'sun'



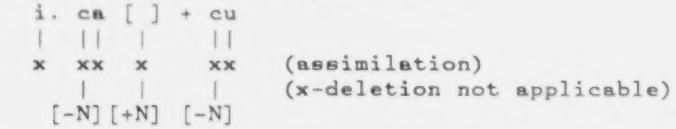
Thus, x-deletion can be formulated as (23), feeding the WFC in (7):

(23) x-deletion

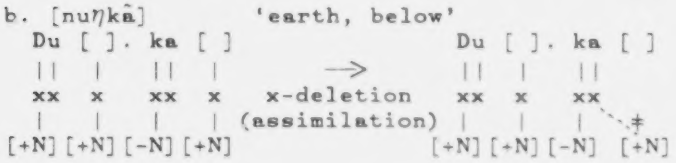


However, it is not the case that every unspecified nasal segment in syllable final position undergoes x-deletion. Under certain circumstances the segment surfaces as a consonant assimilated to the following segment as in the following examples:

(24) a. [icancu] 'maybe the sun'

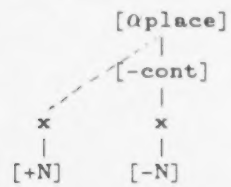


b. [nuŋkã] 'earth, below'



The first empty position on the melody tier of (24.b) and that of (24.a) surface as assimilated nasal segments with the following [-cont] consonants, that is, [ŋ] and [n] respectively. It appears then that the output of assimilation cannot undergo x-deletion. On the other hand, unspecified nasal segments like the second empty position of (24.b) which are not subject to the assimilation rule regularly exhibit x-deletion and as a result, a floating [+N] is created, feeding [+N] spread. The process of assimilation can be formulated as follows:

(25) Place Assimilation



This rule can be interpreted such that if an unspecified nasal segment is followed by an obstruent which has [-cont] feature value, the place feature values of the following obstruent will spread to the preceding empty position of the melody tier(cf. Clements 1985). The fact that examples (22.a) and (22.b) do not undergo the process of assimilation verifies rule (25), since /s/ and /š/ do not satisfy the condition [-cont].

3.4. Constraints on Geminates

At this point we can raise the question as to why (23) should be blocked from applying to forms which have undergone rule (25). Given that (25) produces partial 'geminate' structures, the linking constraint (LC) suggested by Hayes(1986) or the uniform applicability condition(UAC) of Steriade and Schein(1986) might be expected to provide a solution to this problem.[8]

Let us first discuss the applicability of the LC. Hayes suggests that when an association line between autosegments on two tiers is represented in the structural description of a phonological rule, it is interpreted as the sole association connecting either autosegment to elements on the other tier. He formulates the interpretation of association lines as follows:

(26) The Linking Constraint (Hayes 1986)
Association lines in structural descriptions are interpreted as exhaustive .

---

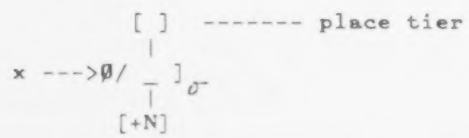
[8]The proposals are both derivative of the well-known generalizations below established by Guerssel(1978), Kenstowicz and Pyle(1973).

Geminate structures cannot
a. be split by epenthesis;
b. allow one half of the cluster to undergo a rule which the other half does not undergo.

It is (b) which is at issue here.

According to this constraint, it appears that the output of (25)[9] can undergo rule (23), since the only association line between the x-node and the [+N] node in the structure of (25) satisfies the structural description of (23) which does not mention any condition on the place tier. Accordingly the LC cannot prevent (23) from applying to the output of (25). In order to invoke Hayes' LC, we could require that the structural description of (23) contain an empty position for a place node which is linked to the x-node as in (27).

(27) x-deletion



In other words, if we introduce an unspecified empty position in underlying representation to the structural description of rule (23) as in (27), Hayes' LC can block (23) from applying to the output of (25) which contains doubly linked lines between x and a place node, since the rule of x-deletion requires a singly-linked line between x and a place node in its structural description. Even though it might be true that the addition of an unspecified position in the structural description makes rule (27) unnecessarily complicated, since the LC seems to arbitrarily manipulate the association lines to result in the correct predictions, we cannot but adopt the LC as a conceivable solution because except for this defect, the LC is valid for multiple tiers. Thus we will take rule (27) as the x-deletion rule to be compatible with the LC. Furthermore we suggest that rule (25) be rewritten as (28) in accordance with (27) in notation by adding an empty slot linked to x (Hayes 1986).

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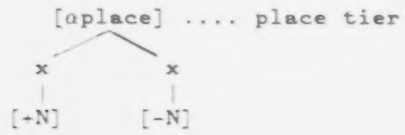
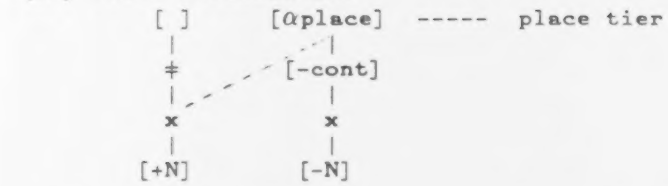
[9]The structure of the output of (25) would be described as follows:



(28) Place Assimilation



We conclude here that place assimilation bleeds x-deletion by creating doubly linked autosegments, which are subject to the LC.

Let us turn now to discuss the applicability of the other analysis. The Uniform Applicability Condition proposed by Steriade and Schein(1986) is formulated to make precise the observation that geminate structures block rule application:[10]

(29) The Uniform Applicability Condition
Given a node n, a set S consisting of all nodes linked to n on some tier T, and a rule R which alters the contents of n: a condition in the structural description of R on any member of S is a condition on every member of S.

Now let us investigate how the UAC of Steriade and Schein(1986) can provide an adequate account for the interaction of the rules.[11] Rule (25) forms a partial geminate structure by spreading the trigger-segment's place feature values onto the target segment. Geminate blockage offers an explanation for the effect that place assimilation has on the later applicability of the x-deletion rule. In the output of the assimilation rule, the first member of a cluster which will contain a single place node satisfies the structural description of x-deletion. However, the second member of the cluster fails to satisfy the x-deletion rule for two reasons: it is not a [+N] and it is not syllable final. Therefore geminate blockage ensues, since the rule cannot apply without affecting both members.

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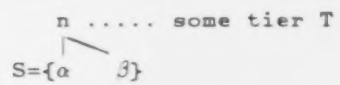
[10]According to them, the blocking configuration is illustrated like this:



,where n can be some node of any tier excluding the skeletal tier and α and β which are linked to n stand for several nodes on some tier including the skeletal tier.

[11]We will discuss the UAC under the same condition as in the case of the LC by dealing with the rules (23) and (25), not with (27) and (28), although we can predict that both sets of rules have the same consequence in terms of the UAC.

Steriade and Schein confine the UAC to the case in which the contents of n are to be altered by a phonological rule. In other words, a rule which applies to the node n, n a skeletal slot, cannot be constrained by the UAC. According to their argument, the UAC cannot prevent the x-deletion rule from applying to the forms which have undergone the assimilation rule, since the x-deletion rule which is corresponding to a rule R in (29) is not a rule which alters the contents of n, but a rule which deletes a node n, where n is a skeletal slot.

They claim that the UAC is superior to the LC in the explanation of geminate blockage in the sense that the UAC predicts geminate blockage from aspects of the rule that must be invariant under any formalization. On the other hand, the aspects of the structural description on which the LC focuses(the number of association lines mentioned) can be arbitrarily manipulated so as to nullify any predictions made about geminate behavior. That is to say, Steriade and Schein insist that the UAC provides observable predictability of geminate blockage and its clearly limited occurrence, while the LC simply provides us with the formal means of stipulating , for any rule, which nodes, in context or target, can be multiply linked, and to which tiers(cf. Steriade and Schein 1986: 64-67).

However, the UAC also needs to be amended to account for what they call the unmarked case, where the contents of n are not being affected and any condition imposed by a rule R on some node of the set S in (29) is a condition on the given node alone. From this fact we argue that the x-deletion rule corresponds to the unmarked case because x-deletion is not a rule which alters the contents of n, namely x-deletion is not a feature changing or feature filling rule. Therefore, as the condition in the structural description is just for the first x of the geminate structure, we can apply the x-deletion rule to the output of the assimilation rule in (25) without considering the condition of the second member of the geminate structure.

Thus we suggest that the UAC be extended to a rule which applies to a

slot in the skeletal tier as well as a rule which alters the contents of n in a geminate structure. The extended version of the UAC might be given as below:

(30) **The Extended Uniform Applicability Condition**
Given a node n including a skeletal node, a set of S consisting of all nodes linked to n on some tier T, and a rule R which deletes n as well as alters the contents of n: a condition in the structural description of R on any member of S is a condition on every member of S.[12]

We are led to conclude that the failure of assimilated nasal consonant cluster to undergo x-deletion is a consequence of the Extended UAC, since the second skeletal slot in the output of rule (25) does not satisfy the condition in the structural description of the x-deletion rule which requires the association with [+N] and syllable final position.

The remaining task is to determine whether the Extended UAC can form part of a general theory or not. For this question, let us examine another rule, namely, a degemination rule which also has a function to delete a skeletal slot x. In general a degemination rule can be formulated as follows:

(31)

a. $x \text{ ---}>\emptyset / \text{ } -\ \overset{[\alpha F]}{\diagup\diagdown}\ x$ b. $x \text{ ---}>\emptyset / \text{ } x\ \overset{[\alpha F]}{\diagup\diagdown}\ -$

The output of the application of either version of (31) yields eventually the same structure as that of the right hand side of the arrow in (32).

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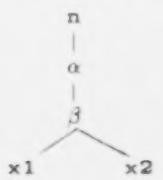
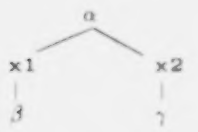
[12] In the following configuration, the node n is assumed to be linked to the nodes, α, β, x1, and x2, where β, x1, and x2 are not directly linked to n.



Likewise, we assume that the second skeletal node is linked to the first one. That is to say, the second skeletal node is a member of a set S consisting of all nodes linked to the first skeletal node which corresponds to a node n. This configuration is viewed as follows:

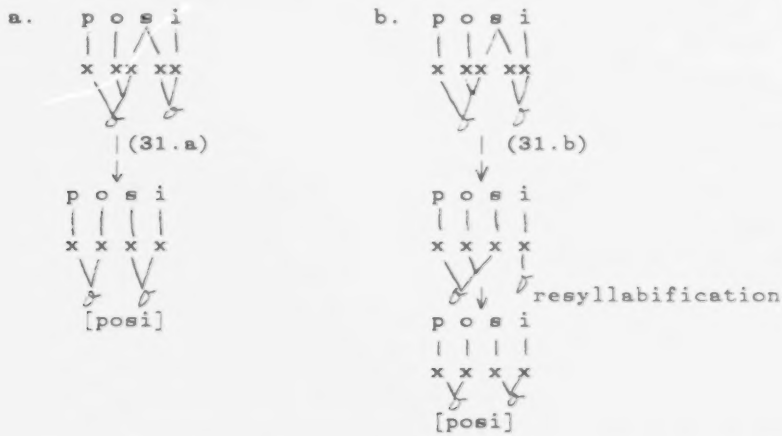


n=x1
S={α, β, γ, x2}

(32)

One example of this sort of degemination process takes place in Attic, one of the Greek dialects discussed in Steriade(1982): the application of either version of (31) results in the same derivation of Attic posi 'feet-DAT' from underlying /pod-si/ through the geminate stage possi without leading to Compensatory Lengthening.

(33)



Note that there is no known evidence as to which x is deleted, the first one or the second in (32), since both versions bring out the same result on the surface. In this sense, we can predict that the Extended UAC cannot block the deletion of one of two x's on the skeletal tier in a degemination rule, since each x which corresponds to a member of a set S satisfies the condition in the structural description of a degemination rule. Thus I propose that the Extended UAC which is motivated from the grammar of Aguaruna might be considered as a sort of a general rule. However, I adopt the LC for the explanation of the interaction between x-deletion and place assimilation, since the LC seems to predict a narrower class of rules which expresses linguistically significant generalizations within a narrower span than

the UAC.[13]

3.5. Cyclicity in the Grammar

We turn now to look at the examples in (22) in detail. In (22.c) the first unspecified nasal cannot undergo rule (28) because the following element is associated with [+N]. Therefore it can be deleted in syllable final position by means of rule (27). However, the second nasal consonant cannot be deleted or assimilated because it is followed by an underlying vowel, and furthermore it is not unspecified, even though the nasal consonant appears in word final position on the surface. From this fact we are led to conclude that the Vowel Deletion Rule applies after x-deletion, and that syllabification precedes both of these rules. Moreover, the relevance of the phonological cycle with respect to syllabification must be examined in more detail.

The theory of cyclic rule application in phonology has been developed since Mascaro(1976), by a number of linguists including Mohanan(1982), Harris(1983), Kiparsky(1982), Pulleyblank(1983), and Sproat(1985). Among cyclic rules in phonology we focus on the cyclicity of rules of syllabification. Harris(1983) proposes that the rules of syllable structure assignment apply cyclically. But syllable structure rules do not obey the Strict Cycle Condition proposed by Mascaro(1976), since they must apply in nonderived

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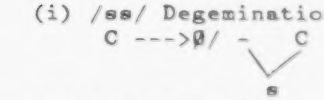
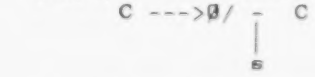
[13]The UAC seems to be limited to only the rules relevant to geminate structures, while the LC can broadly apply to any phonological rules within a narrower span; for instance, the LC makes distinction of /ss/ Degemination from /s/ Deletion depending on the linkings of the /s/ melodic segment as follows(Hayes 1986).

(i) /ss/ Degemination



(ii) /s/ Deletion

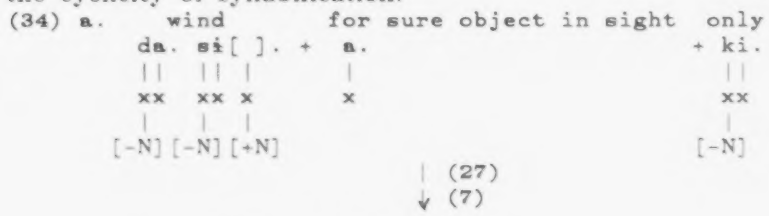


These two rules cannot be collapsed into one. Each rule is an independent general phonological rule.

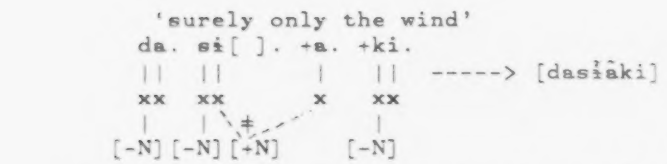
as well as derived contexts.[14] He argues further that syllable structure in nonderived contexts is just as predictable as in derived contexts, and furthermore obeys exactly the same generalizations.

It is our aim here to provide more evidence for Harris's argument by means of the data of Aguaruna, in which syllable structure assignment must apply cyclically in order to feed x-deletion. The examples in (34) illustrate the cyclicity of syllabification.

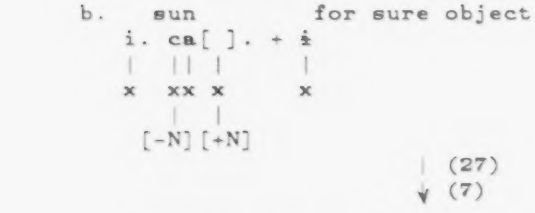
(34) a.



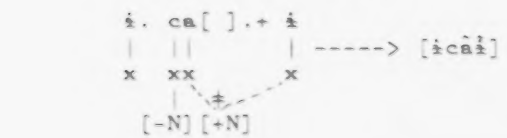
'surely only the wind'



b.

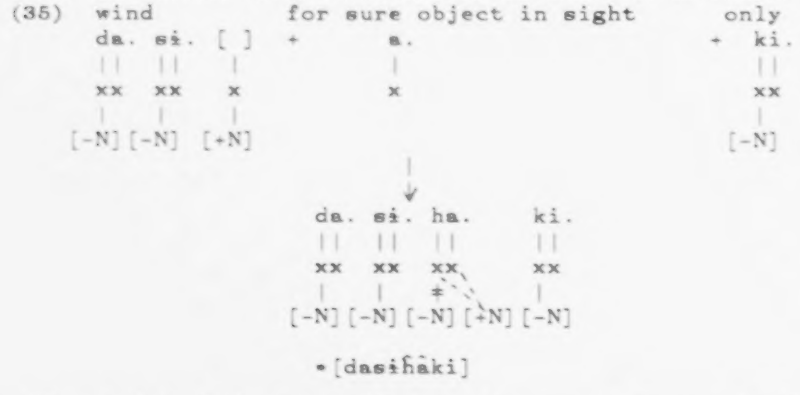


'surely the sun'



[14] Mascaro argues in his dissertation(1976) that the class of rules which applies only in derived contexts(that is, a crucial part of the environment triggering the rule is derived by an earlier rule or across a morpheme boundary) is the class of cyclic rules.

In each derivation of the above examples the x-deletion rule applies after cyclic syllabification, since it is fed by syllable structure assignment, which creates a derived environment. Suppose that syllabification applies strict-cyclically to (34.a); then the output of syllabification does not feed x-deletion. Thus the surface form turns out to be incorrect as shown in (35).



The x slot of the unspecified nasal segment cannot be deleted because it is not in syllable final position. In sequence, the empty position of the melody tier appears with /h/ which undergoes nasalization by virtue of other rules. These rules will be formulated in the next section.

In short, these examples show us that cyclic assignment of syllable structure plays a crucial role in making the unspecified nasal segment occur in syllable final position. It appears then that syllabification in the grammar of Aguaruna does not obey the principle of strict cyclicity for the same reason as Harris points out: it must apply in nonderived context of a root cycle as well as derived contexts across morpheme boundaries, and it must apply cyclically. Thus we conclude here that the grammar of Aguaruna makes a contribution in supporting the proposal that syllable structure assignment rules are applied cyclically, but not strict-cyclically.

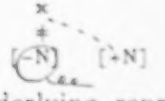
3.6. The behavior of /h/

Another remarkable aspect of nasal harmony in Aguaruna is the behavior of /h/. Observe that the vowels to the left of /h/ in (36) may or may not be nasalized. This phenomenon can be accounted for by the assumption mentioned earlier that /h/ is underlyingly associated with [-N] unlike /w/ and /y/. This association line plays a role in blocking leftward nasal spreading.

(36) a. ni.ha̰ỹ.ĩ 'his forehead'
b. mɨ.hĩ.ã.w̃ã.ĩ 'it stinks'
c. na.ha̰.w̃ɨ̰ 'goblins'
d. cu.ka.hɨ̰ 'his mouth'
e. nũ.ha̰.w̃ã.ĩ 'the river is rising'
f. ã.hũ.m 'later'

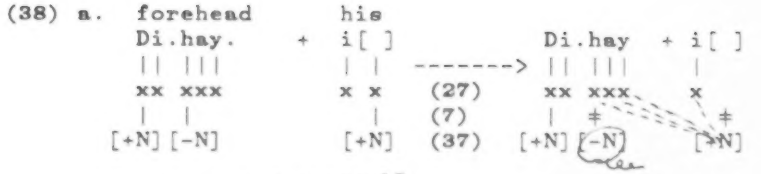
However, we can observe that the result of harmony will be /h/ with contour nasal harmony, violating the Well-formedness Condition of (7). Thus the analysis requires another rule to delink [-N] from the skeleton to satisfy the Well-formedness Condition of (7). After that, a stray [-N] is deleted.

(37)



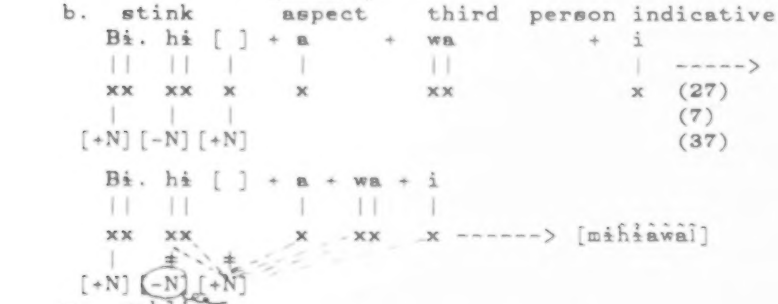
The underlying representations and the process of nasal spread in (35) are shown in (38), in which every example ends up with the correct surface form by means of (37).

(38) a. forehead his

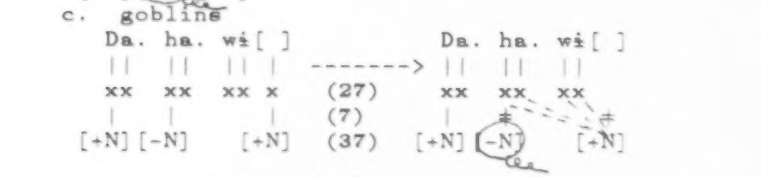


-------> [niĥâŷî][15]

b. stink aspect third person indicative

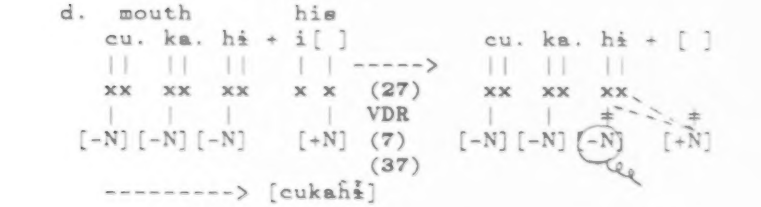


c. goblins



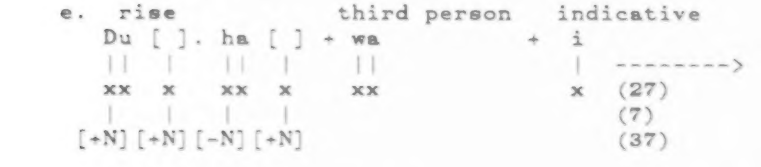
---------> [naĥâŵî]

d. mouth his



---------> [cukaĥî]

e. rise third person indicative



--------> [nûĥâŵâi]

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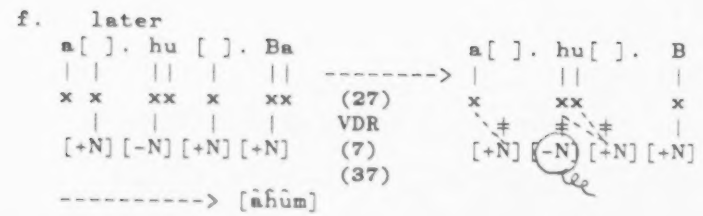
[15]The actual underlying form is represented as /Di.hai + i /. The given underlying form is the output of the application of the phonological rule /i/ --> /y/ / -V.



In addition to the examples which exhibit the behavior of a base generated /h/, there are other examples which show a derived /h/ from a velar nasal stop. We can observe the distribution of derived /h/ in a suffix with the form /Gu/, which has the meaning of either 'aspect' or 'possessive'. This suffix is assumed to have the characteristic of absorbing preceding [+N]'s, unless [-N] intervenes. A floating [+N] cannot spread to the left side of this suffix. This fact can also be accounted for within Autosegmental Theory.

/G/ is changed to /h/ whenever /G/ is followed by a vowel. We propose that the [-cons] feature on the root tier of a vowel spreads to the preceding root node.[16] Once the [-cons] feature of a vowel spreads to the preceding root node of the nasal segment, an associated line with [+N] will be eliminated. On the nasal tier, [+N] is floating and [-N] is inserted before [+N] to be linked to the skeletal slot by a rule. Accordingly /h/ appears on the surface and the association line with [-N] for the specification of /h/ blocks the leftward spreading of a floating [+N]. These processes can be formulated as in (39) and (40).[17]

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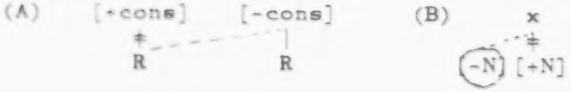
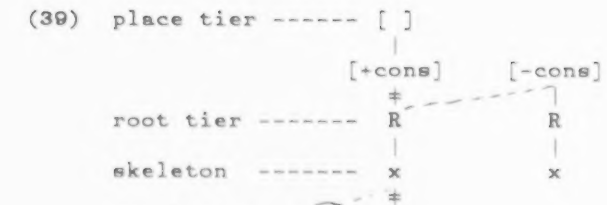
[16]Synchronically this process seems to be a kind of assimilation. Diachronically we find evidence to support this process from Pike and Larson's Aguaruna Phonemics(1964). For the reference, we quote here their remarks: 'Historically many of these more stable, localized nasals seems to be a reflex of an old $*_{-\eta}$ since $*_{\eta} + *_{v} > h\hat{v}$. The nasalization of the vowels, in these instances, does not spread backwards past h, even as it would not past the η.

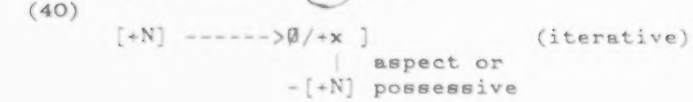
[17]In fact, rule (39) is a result of the combination of the two rules:



(39)



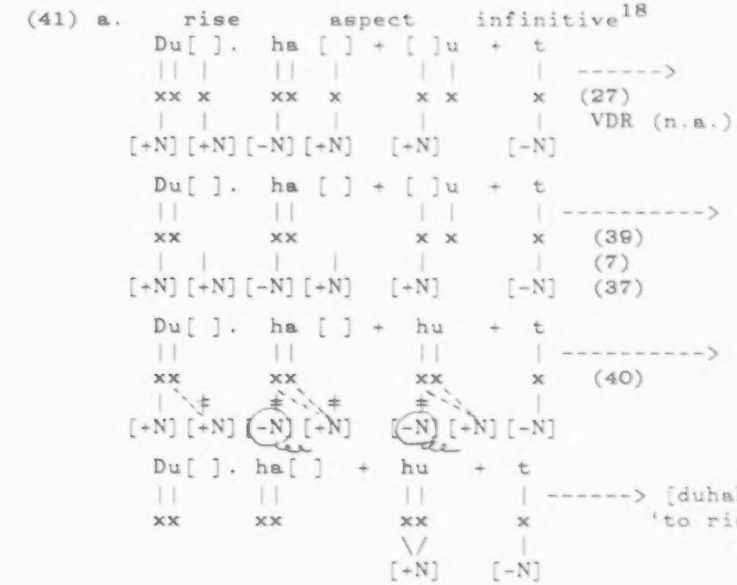
(40)



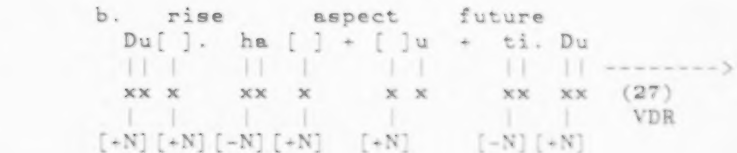
4. Derivations

Now let us consider how these rules interact with the other rules we have formulated so far.

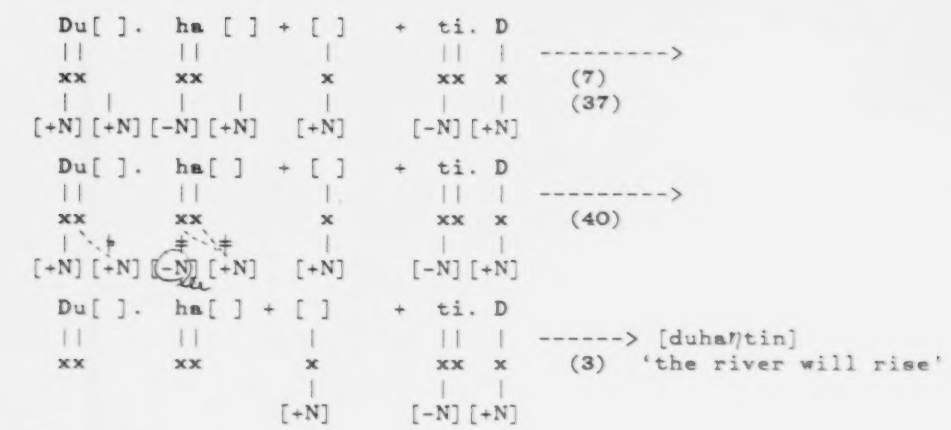
(41) a.



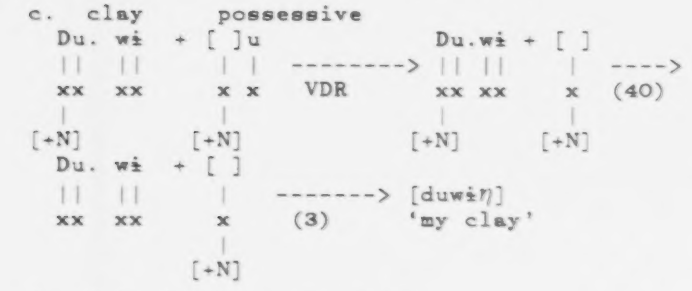
b.



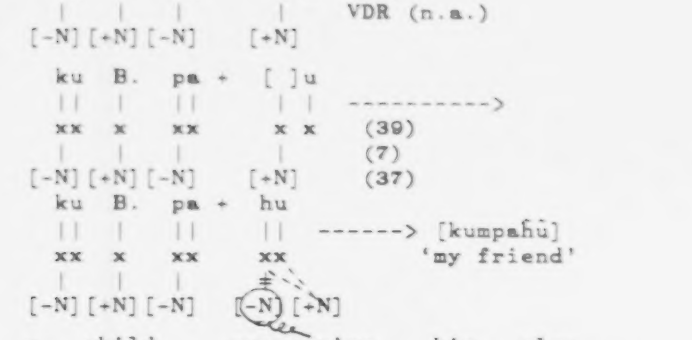
[18] The infinitive suffix is given in an intermediate form after having undergone vowel deletion.



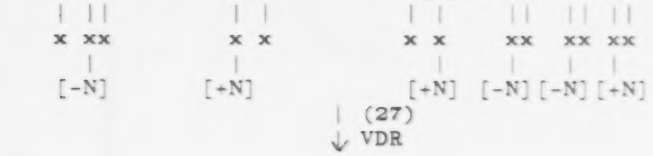
c. clay possessive

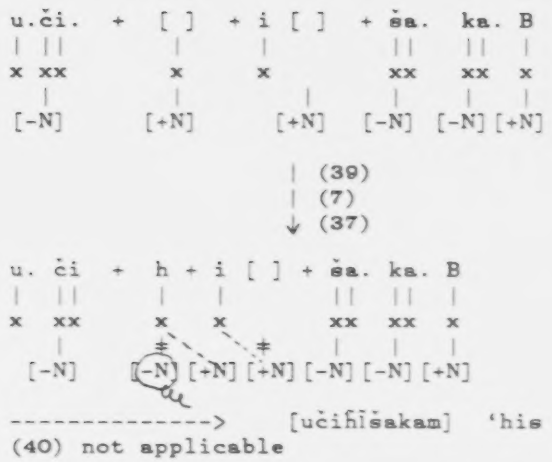


d. friend possessive



e. child possessive his also





In (41.a) since VDR is not applicable to the suffix which means 'aspect', [-N] is inserted by means of rule (39). As a consequence of rule (39), /h/ appears as a surface form and a floating [+N] autosegment is left behind. The suffix iteratively can absorb the preceding [-N] autosegments by means of rule (40) because the intervening [-N]'s are deleted by rule (37). Rule (39) cannot apply to (41.b) because the vowel /u/ of the suffix is deleted by VDR. Thus the empty position on the melody tier is filled by the default rule (3) and surfaces as [η].

In (41.c) we can see the same process as in the (41.b). Example (41.d) shows the application of the place assimilation rule (28). Here, x-deletion is not applicable because the LC blocks it. The possessive suffix cannot delete [+N] of the stem, since [-N] which is linked to /p/ is intervening between the two [-N]'s. Therefore, what blocks the application of rule (40) is not the [-N] for the specification of /h/ which is eventually to be deleted by rule (37), but the [-N] which is linked to /p/.

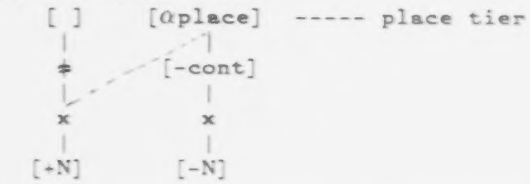
(41.e) is a good example supporting the claim that the suffix which means 'aspect 'or 'possesive' absorbs the preceding [+N]'s, unless [-N] intervenes. The vowel /u/ of the possessive suffix and the vowel /a/ of the suffix which means 'also' are deleted by VDR after x-deletion. Then rule (39) is applicable, since there is another vowel /i/ which follows the possessive suffix across a morpheme boundary. As a consequence of rule (27) and (39), two

floating [+N]'s are produced and these cannot be absorbed by rule (40), since they are not to the left of the possessive suffix. As a result of this derivation, we get the correct surface form [učihĩšakam], in which /h/ and /i/ undergo nasalization.

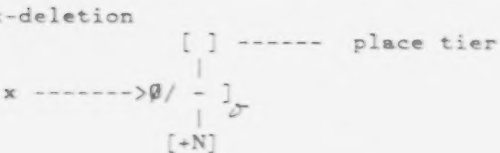
5. Summary and Conclusion

The list in (42) summarizes the ordering relations among the various rules which we have formulated so far within an elaborated version of Autosegmental Theory.

(42) (28). Place Assimilation

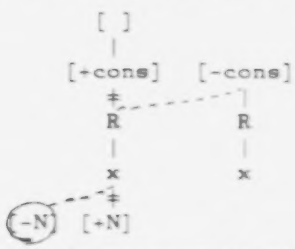


(27). x-deletion



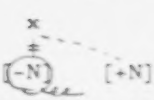
Vowel Deletion Rule

(39).



(7). Well-formedness Condition

(37).



(40). [+N] ---->Ø/ + x]
Aspect or possessive
-[+N]

(3). [ ] ---->[-cor -ant]

The process of nasal harmony in Aguaruna has been well accounted for by means of Autosegmental Theory, namely, by showing that there are different rules which apply on each tier: (27) affects the skeleton without having any

influence on the nasal tier while (40) deletes a nasal autosegment before a nasal feature of the suffix which means 'aspect' or 'possessive'. The outputs of place assimilation undergo geminate blockage, since place assimilation is assumed here to involve autosegmental spreading. Rule (39) is also based on autosegmental spreading.

Furthermore, the interaction of rules (27) and (28) which appear to apply in complementary environments led us to discuss two current arguments with regard to geminate blockage. There was no objection to the argument against the LC as Steriade and Schein pointed out that the LC reveals its weakness by arbitrarily manipulating the number of association lines mentioned in the structural description. Nevertheless, we have demonstrated that the relationship between partial assimilation and x-deletion can be best accounted for in terms of the LC if an empty position is merely specified in the structural description of the x-deletion rule to be compatible with the LC. A defect of the UAC was pointed out and it was argued that the UAC could be extended to be compatible with the data of Aguaruna, where the UAC would block x-deletion from applying to the output of assimilation. The amended UAC was referred to as the Extended UAC and was proposed as a possible alternative solution.

From the fact that x-deletion is fed by cyclic syllabification, while analyzing nasal harmony of Aguaruna, we argued that the data which were dealt with in this paper provide more evidence for Harris's claim that the rules of syllable structure assignment apply cyclically, but not strict cyclically. In this way, the Aguaruna data sheds light on the cyclicity of syllabification, the representation of nasal harmony and the behavior of geminates.

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